Cooperation and (Semi-) Autonomous Driving – A Retrospective and View Ahead

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Abstract

(Semi-)autonomous driving offers not only interesting new technological advancements, but also opens the way for unprecedented cooperation potential, due to less time and resources spent on the act of manually operating the vehicle. During the seven years duration of the Christian Doppler Laboratory for Contextual Interfaces, conducted several studies on novel technologies and their in-car cooperation potentials were conducted. In this paper, I provide a brief overview of some of these studies, together with some unexpected aspects relevant to the world of cooperation and autonomous driving. At the end, I give a summary of the lessons learned, namely that the complexity of the full context and the often difficult to predict needs and intentions of the user can lead to unintended side effects or consequences. I conclude with motivations to help shape the knowledge and progress for cooperation in the automotive context(s) of the future.

Author Keywords

Authors' choice; of terms; separated; by semicolons; include commas, within terms only; required.

ACM Classification Keywords
H.1.2. User/Machine Systems: Human Factors.

Introduction

Nowadays, there is no escaping the dream of autonomous driving. Cars are already equipped with a wide range of Advanced Driver Assistance Systems (ADAS), designed to aid the driver in executing driving tasks or even execute them fully themselves. And the push towards fully autonomous level 4 or 5 [1, 2] autonomous driving is as strong as ever, with not only the Google Car on the horizon but also other manufacturers aiming to introduce their autonomous vehicles to the market [3]. Autonomous driving his is just one aspect of the increasing amount of automation in contemporary times, although it likely is – aside robotics and automation in factory environments – one of the more important ones. The car is a delicate design space, where safety is paramount and even slight distractions can have disastrous consequences – not just for the driver of the affected vehicle, but often other drivers or road users, too. But the car is also occupying a considerable amount of people's daily times, so there is certainly great incentive to use this time efficiently, instead of spending it with routine driving tasks. It would be even better, if these tasks were done by a system that is actually better at it than the average human individual, as this would free up resources for work, communication or cooperative activities, while reducing accidents at the same time. While the technical progress is not quite there yet, it is important to address the individual and User Experience related factors of these novel autonomous contexts as soon as possible, so that they can be used efficiently, once the technology is ready.

Activities during autonomous transport are expected to cover a wide range of contexts, so appropriately context sensitive designs need to be pursued for an adequate UX in each context. Cooperation and Collaboration encompass a wide range of such contexts and are arguably the most promising ones. These can be navigational in nature, or, to provide another example, consist of individuals collaboratively preparing for a meeting while driving to that meeting in separate vehicles.

Studies

In this paper, I want to talk about three studies and the sometimes unexpected lessons learned from them. In two of these, I participated in the research and for the third as a scientific study subject. All of them were done in the course of the CDL project. I adopt a simplified notion of collaboration from Perterer et al. [5] and use the terms 'cooperation' and 'collaboration' in a wider sense. In the former, individuals work together to achieve a common goal, whereas in the latter, individuals work together to achieve selfish yet common goals. Erring on the side of caution, I will use 'cooperation' throughout most of this paper.

The first study I am going to talk about was about "Active Corners", a novel car interaction system, which takes into account the social nature of the car context that is created by the driver, front seat and back seat passengers The Active Corners System consists of tablets installed in each car position, with the possibility to send media content to another position by simply dragging the content in question into the appropriate corner (each corner represents one of the four positions driver, co-driver, back seat left, back seat right). This enables cooperative human interaction during

secondary or tertiary driving tasks of the driver, as well as the other passengers. The expectation was that the system would be used to mostly exchange navigation information with the driver, while the other seat positions would use it to share other content (music, videos) or use it to play games, etc. During evaluation in actual vehicles, it turned out that, while the system worked pretty well, a number of participants missed traditional communication modes in the car, fearing that using the system would actually cause a less lively atmosphere, rather than enhanced communication and cooperation.

The second study was about an auditory communication enhancement in the car, which allowed hearing audio content directly through the headrests. The idea was to combine this system with the aforementioned Active Corners System in order to provide a communication environment free of the barriers usually occurring in cars (headrests, all seats directed forwards, etc.). During testing the system with users, it worked as it should in most respects but there was something that we had not expected: Similar to the findings from the previous study, the users did not mind these barriers and were actually too used to them. Whenever they felt like communicating directly, they would move in their seats, turn around, etc., which all meant that they were now further away from the sound source, which then made it hard to hear. So in this case, we had a technology designed to enhance communication and cooperation, which was actually detrimental to it.

In the third study, the subject of the study was a persuasive system intended to keep the driver from speeding. The setup was simple: as the driver's speed increased, so did the speed of the falling pieces. The intention was to adjust the speed such, so that it would be too fast when the driver was speeding, thus incentivizing the player to persuade the driver to speed down in such cases. While this study was not directly related to automation, it was one of the instances, where the difference between cooperation and collaboration really showed and which is why it is worth mentioning here. The driver's goal was to drive without being nagged by the player, while the player's goal was to have a fun game. This was fine, as long as the player was not one who enjoyed a good challenge – which was the case with me among others. So if I wanted to have an enjoyable game, which consisted in challenging myself constantly further, I had to nag the driver to speed up more and more, which was the exact opposite of the intended persuasive design.

Lessons Learned

Once again, the context had turned out to be more complex than it had seemed initially and individual user factors and variables need to be incorporated in the system design. All three studies show similar examples of cases, in which context and user factors were not taken into account in full and led to unintended consequences, often contrary to the initial design goals. In the first study, a technology designed to enhance communication and cooperation in the car, had turned out to work *too* well, to the point where it could actually be detrimental to communication frequency. Similarly, the second study had a system that, while working well, changed the context such that it put the participants in an unfamiliar and, therefore communication-hindering situation. In the third case, the lack of focus on separate goals in a cooperative setting could lead to behavior contradictory to the

actual design goal. If we want to avoid such potential hazards and have adequate and user-specific collaborative and cooperative solutions in the autonomous world of tomorrow, then we need a research programme that puts these aspects first and then designs appropriate systems around them.

Short Biography

I am a Research Fellow at the Center for Human-Computer Interaction, focusing on knowledge transfer, design patterns, and theory of definitions in HCI. I hold a Master's Degree in Analytic Philosophy from the University of Salzburg and am currently working on my PhD in HCI. I have a background in Philosophy of Science, Epistemology, Ethics, and Neuroscience. I have been involved in several international research projects and did work on system-user trust and security feedback, automotive driver space design patterns, user experience definitions, and ethical aspects in practical science. In my PhD thesis, I am currently exploring the potential of patterns as a general knowledge transfer tool for both science and industry.

In 2015, I joined the MaDSAV project and shifted my focus strongly towards autonomous driving. In the course of this work, I have noticed a lot of technology enthusiasm sweeping away concerns and short-term problems, which I feel could be addressed if we would put more emphasis on the user side of things. Having worked closely with individuals from the automotive industry during this time, it seems that what we are doing currently is chasing technological progress. If the user is even mentioned in autonomous driving settings, then mostly only regarding acceptance – where 'acceptance' is often another word for 'marketing'.

If we really want to have context-sensitive autonomous vehicles, that are not just glorified taxis, then we need to be serious about addressing their UX related aspects and especially cooperation and collaboration, as all the time commuting could be spent with less accidents and much more productively – *if* we get both the system- and user-centered sides right. This is why I have strong interest in joining research efforts focusing on bringing automation and people together and do my part to contribute to realizing the potentials of our current and future technologies; and this can only happen if we treat humans and automated systems in the same research, and not isolated from each other.

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References

1. A. Stevens, A. Quimby, A. Board, T. Kersloot, and P. Burns, NHTSA Design Guidelines for Safety of In-Vehicle Information Systems. National Highway Traffic Safety Administration, 2002.
2. SAE International Standard J3016. 2014. Free Summary. Retrieved January 2016 from http://www.sae.org/misc/pdfs/automated_driving.Pdf
3. http://www.usatoday.com/story/tech/2016/01/05/kia-aims-self-driving-car-2030/78330214/. Retrieved March 2016.
4. Open Roboethics Initiative. 2014. Kids with wheels: Should the unlicensed be allowed to 'drive' autonomous cars?. Retrieved January 13, 2016 from http://robohub.org/kids-with-wheels-should-the-unlicensed-be-allowed-to-drive-autonomouscars/
5. N. Perterer, P. Sundström, A. Meschtscherjakov, D. Wilfinger, and M. Tscheligi, "Come Drive with Me:

An Ethnographic Study of Driver-Passenger Pairs to Inform Future In-Car Assistance," in Proceedings of the ACM 2013 conference on Computer Supported Cooperative Work Companion (CSCW 2013)., 2013, pp. 1539-1548.